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Test Report

AIR-CAP3502P-A-K9 Cisco Aironet 802.11n Dual Band Access Points

FCC ID: LDK102073P IC: 2461B-102073P

(Also covers AIR-CAP3502P-N-K9, AIR-CAP3502P-T-K9)

5725-5850 MHz

Against the following Specifications: CFR47 Part 15.247 RSS210

Cisco Systems

170 West Tasman Drive San Jose, CA 95134

Page No: 1 of 54

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SECTION 1: OVERVIEW	3
1.1 TEST SUMMARY	3
SECTION 2: ASSESSMENT INFORMATION	4
2.1 GENERAL	4 5 5
SECTION 4: SAMPLE DETAILS	6
APPENDIX A: EMISSION TEST RESULTS	8
Average Output Power	
99% and 26dB Bandwidth Peak Quitput Power	
Power Spectral Density Conducted Spurious Emissions	
APPENDIX B: EMISSION TEST RESULTS	35
Radiated Bandedge Radiated Spurious Emissions Maximum Permissible Exposure (MPE) Calculations	
APPENDIX C: TEST EQUIPMENT/SOFTWARE USED TO PERFORM THE TEST.	54

Page No: 2 of 54

Section 1: Overview

1.1 Test Summary

samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:

Emission	Immunity
CFR47 Part 15.247 RSS210	N/A

The specifications listed above represent actual tests performed to demonstrate compliance against the specifications

and basic standards listed on the front cover of this report. This list is not a one to one match to the front cover for one

or more of the following reasons.

- 1. Basic standards call up many different test phenomena specifications such as the 61000-4-X series. The basic standards define which elements and levels shall be applied from these specifications and as such it is not appropriate to list the individual specifications on the front cover.
- 2. A Standard listed on the front cover may be required in a particular country but is not appropriate for the particular technologies included in the equipment under test. E.g. You cannot test a DC product to the mains Harmonics requirements in EN61000-3-2. See section 3.2.
- 3. Test results against a particular standard or specification may be included in a different test report. See section 3.2 for an EDCS reference of this data.
- 4. Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
- 5. Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.
- 6. Testing may have been performed to an equivalent test that satisfies the requirements of the standards and specifications listed on the front cover of the report. See section 3.2.
- Where radiated emissions testing has been performed to EN55022/CISPR22 the additional requirements of VCCI: V- 3/2006.04, EN55022: 1994 +A1/2 and CAN/CSA- CISPR 22-02 have also been evaluated unless otherwise stated.
- Testing to the requirements of CFR47 Part 15 was performed against the CISPR22 limits. The results are therefore deemed satisfactory evidence of compliance with Industry Canada Interference Causing Equipment Standard ICES-003.
- 9. Where assessment has been performed to CISPR24, all the applicable test requirements may have not been covered. Refer to the results section for the tests performed.

Notes:

- 1) Where a specification listed on the front cover of this report has deviations from the basic standards listed above, the additional technical requirements of the specification were also assessed.
- 2) Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
- 3) Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.

Page No: 3 of 54

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc:

With regard to this assessment, the following points should be noted:

- a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.
- b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.
- c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).
- d) All testing was performed under the following environmental conditions:

Temperature15°C to 35°C (54°F to 95°F)

Atmospheric Pressure 860mbar to 1060mbar (25.4" to 31.3")

Humidity 10% to 75*%

*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.

e) All AC testing was performed at one or more of the following supply voltages:

110V 60 Hz (+/-20%) 220V 50 Hz (+/-20%)

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Page No: 4 of 54



2.2 Date of start of testing

13-July-2010

2.3 Report Issue Date

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2.4 Testing facilities

This assessment was performed by:

Testing Laboratory

Cisco Systems, Inc.,	Cisco Systems, Inc.
4125 Highlander Parkway	170 West Tasman Drive
Richfield, OH 44286	San Jose, CA 95134
USA	USA

Test Engineers

James Nicholson

2.5 Equipment Assessed (EUT)

AIR-CAP3502P-A-K9 Cisco Aironet 802.11n Dual Band Access Point

2.6 EUT Description

The AIR-CAP3502P-A-K9 Cisco Aironet 802.11n Dual Band Access Points requires professional installation, and supports the following modes of operation. The modes are further defined in the radio Theory of Operation. The modes included in this report represent the worst case data for all modes.

Legacy OFDM, Non HT-20, Single Antenna, 6 to 54 Mbps Legacy OFDM, Non HT-20, Dual Antennas, 6 to 54 Mbps Legacy OFDM , Non HT-20 Dual Antennas with Beam Forming, 6 to 54 Mbps HT-20, Single Antenna, M0 to M7 HT-20, Dual Antennas, M0 to M15 Non HT-40 Duplicate, Single Antenna, 6-54 Mbps Non HT-40 Duplicate, Dual Antennas, 6-54 Mbps HT-40, Single Antenna, M0 to M7 HT-40, Dual Antennas, M0 to M15

Page No: 5 of 54

The following antennas are supported by this product series. The items in bold will be specifically tested and cover all others. The data included in this report represent the worst case data for all antennas.

......

			Antenna Gain
Frequency	Part Number	Antenna Type	(dBi)
	AIR-ANT2422DB-R	Articulating black dipole	2
	AIR-ANT4941	Articulating black dipole	2
	AIR-ANT2422DG-R	Non-articulating gray dipole	2
	AIR-ANT2422DW-R	Articulating white dipole	2
	AIR-ANT2422SDW-R	Stubby monopole	3
	AIR-ANT2430V-R	3-elementMIMO ceiling mount omni	3
	AIR-ANT2440NV-R	3-element MIMO wall/mast mount omni	4
2.4 GHz	AIR-ANT1728	indoor omni	5
	AIR-ANT2450S-R	Sector	5
	AIR-ANT2506	Outdoor omni	5
	AIR-ANT2460P-R	Patch	6
	AIR-ANT2460NP-R	3-element MIMO patch	6
	AIR-ANT2485P-R	Patch	8.5
	AIR-ANT2410Y-R	Yagi	10
	AIR-ANT1949	Yagi	13.5
	AIR-ANT5135D-R	Articulating dipole	3.5
	AIR-ANT5135DB-R	Articulating dipole	3.5
	AIR-ANT5135DG-R	Non-articulating gray dipole	3.5
	AIR-ANT5135DW-R	Articulating white dipole	3.5
5 GHZ	AIR-ANT5135SDW-R	Stubby monopole	3.5
	AIR-ANT5140V-R	3-element MIMO ceiling mount omni	4
	AIR-ANT5160V-R	Omni-Directional	6
	AIR-ANT5160NP-R	3-element MIMO patch antenna	6
	AIR-ANT2451NV-R	MIMO 6-Element Dual Band Omni	2.5 / 3.5
2.4/5 GHZ	AIR-ANT25137NP-R	Patch	13/7

Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for worst Case test Configuration" section of this report for further details on the selection of EUT samples.

Page No: 6 of 54



4.1 Sample Details (Photographs of the test samples, where appropriate can be found in appendix H)

Sample No.	Equipment Details	Part Number	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01	AIR-CAP3502P-A-K9		Cisco Systems	NA	NA	NA	
S02	AIR-PWR-B	341-0306-01	Cisco Systems	NA	NA	NA	
S05	AIR-ANT5160V-R						
S06	AIR-ANT25137NP-R						

4.2 System Details

System #	Description	Samples
1	EUT	S01, S02

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Continuous Transmitting	Continuous Transmitting

Page No: 7 of 54

Appendix A: Emission Test Results

Testing Laboratory: Cisco Systems, Inc., 4125 Highlander Parkway, Richfield, OH, USA

Average Output Power

Connect the antenna(s) to the power meter at the average power sensor input. Configure the power meter to measure average power for the transmitter frequencies listed below (enter all losses between the transmitter output and the power meter).

......

Place the radio in continuous transmit mode and record the reading on the power meter.

			Target Power Level		Actual Power Level	
Frequency	Mode	Data Rate	Tx A	Tx B	Total	Total
5745	Non HT-20 Beam Forming	54	17	17	20	19.7
5785	Non HT-20 Beam Forming	54	17	17	20	19.7
5825	Non HT-20 Beam Forming	54	17	17	20	19.7
5745/5765	Non HT-40 Duplicate	54	17	17	20	19.9
5745/5765	HT-40	M7	17	17	20	19.7
5785/5805	Non HT-40 Duplicate	54	17	17	20	19.9
5785/5805	HT-40	M7	17	17	20	20.1

Page No: 8 of 54

6dB Bandwidth

15.247: Systems using digital modulation techniques may operate in the 5725-5850MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.

Connect the antenna port(s) to the spectrum analyzer input. Using the spectrum analyzer Channel Bandwidth mode, configure the spectrum analyzer as shown below (enter all losses between the transmitter output and the spectrum analyzer).

Center Frequency:	Frequency from table below
Span:	2 x Nominal Bandwidth (e.g. 40MHz for a 20MHz channel)
Reference Level:	20 dBm
Attenuation:	10 dB
Sweep Time:	5 s
Resolution Bandwidth:	100 kHz
Video Bandwidth:	100 kHz
X dB Bandwidth: 6 dB	
Detector:	Peak
Trace:	Single

Place the radio in continuous transmit mode. View the transmitter waveform on the spectrum analyzer, and record the pertinent measurements:

Frequency (MHz)	Mode	Data Rate (Mbps)	6dB BW (MHz)	Limit (kHz)	Margin (MHz)
5745	Non HT-20 Beam Forming	54	16.6	>500	16.1
5785	Non HT-20 Beam Forming	54	15.6	>500	15.1
5825	Non HT-20 Beam Forming	54	15.6	>500	15.1
5745/5765	Non HT-40 Duplicate	54	35.3	>500	34.8
5745/5765	HT-40	M7	32.9	>500	32.4
5785/5805	Non HT-40 Duplicate	54	35.2	>500	34.7
5785/5805	HT-40	M7	35.7	>500	35.2

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6dB BANDWIDTH, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Page No: 10 of 54

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🔆 Agilent	Measure
Ch Freq 5.825 GHz Trig Free	Meas Off
	Channel Power
Ref 20 dBm #Atten 10 dB #Peak Log 10	Occupied BW
10 dB/ 0ffst 25	ACP
dB Center 5.825 00 GHz Span 40 MHz ²	Multi Carrier Power
#Res BW 100 kHz #VBW 100 kHz #Sweep 5 s (601 pts) Occupied Bandwidth Occ BW % Pwr 99.00 % 1c 2cc / MU x dB -6.00 dB	Power Stat CCDF
Transmit Freq Error 19.745 kHz x dB Bandwidth 15.607 MHz*	More 1 of 2
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6dB BANDWIDTH, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths

6dB BANDWIDTH, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths

* Agilent	Measure
Ch Freq 5.755 GHz Trig Free Occupied Bandwidth	Meas Off
	Channel Power
Ref 20 dBm #Atten 10 dB #Peak Log → ↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑	Occupied BW
dB/ dB/ 0ffst 25	ACP
dB Center 5.755 00 GHz Span 80 MHz	Multi Carrier Power
#Res BW 100 kHz #VBW 100 kHz #Sweep 5 s (601 pts) Occupied Bandwidth Occ BW % Pwr 99.00 % Эс 1 сс 4 мц x dB -6.00 dB	Power Stat CCDF
JOLLOO4 MHZ Transmit Freq Error 144.594 kHz x dB Bandwidth 35.263 MHz*	More 1 of 2
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Page No: 11 of 54

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⁶dB BANDWIDTH, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths

🔆 🔆 Agilent	Measure
Ch Freq 5.795 GHz Trig Free Occupied Bandwidth	Meas Off
	Channel Power
Ref 20 dBm #Atten 10 dB #Peak Log →♠₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩	Occupied BW
dB/ 0ffst 25	ACP
dB	Multi Carrier Power
#Kes BW 100 kHz #VBW 100 kHz #Sweep 5 s (601 pts) Occupied Bandwidth Occ BW % Pwr 99.00 % 36 2325 MHz × dB -6.00 dB	Power Stat CCDF
Transmit Freq Error 126.420 kHz × dB Bandwidth 35.250 MHz*	More 1 of 2
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Page No: 12 of 54

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6dB	BANDWIDTH.	5785/5805 MHz	M7	HT-40	Dual	Transmit	Paths
oub	DAND MIDTH,	, 57 05/ 5005 Will 12	, IVI <i>I</i> ,	, III - T U,	Duai	mananni	i auio



Page No: 13 of 54

99% and 26dB Bandwidth

Connect the antenna port(s) to the spectrum analyzer input. Using the spectrum analyzer Channel Bandwidth mode, configure the spectrum analyzer as shown below (enter all losses between the transmitter output and the spectrum analyzer).

Center Frequency:	Frequency from table below
Span:	2 x Nominal Bandwidth (e.g. 40MHz for a 20MHz channel)
Reference Level:	20 dBm
Attenuation:	10 dB
Sweep Time:	5 s
Resolution Bandwidth: Video Bandwidth: ≥Reso X dB Bandwidth: 26 dB	1%-3% of 26 dB Bandwidth Ilution Bandwidth
Detector:	Peak
Trace:	Single

Place the radio in continuous transmit mode. View the transmitter waveform on the spectrum analyzer, and record the pertinent measurements:

Frequency (MHz)	Mode	Data Rate (Mbps)	26dB BW (MHz)	99% BW (MHz)
5745	Non HT-20 Beam Forming	54	25.1	17.1
5785	Non HT-20 Beam Forming	54	27.5	17.0
5825	Non HT-20 Beam Forming	54	29.1	17.0
5745/5765	Non HT-40 Duplicate	54	70.7	41.3
5745/5765	HT-40	M7	60.2	36.8
5785/5805	Non HT-40 Duplicate	54	74.6	41.4
5785/5805	HT-40	M7	57.0	36.5

Page No: 14 of 54



99%/26 dB Bandwidth, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths

99%/26 dB BANDWIDTH, 5785 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Page No: 15 of 54

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99%/26 dB BANDWIDTH, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths

99%/26 dB BANDWIDTH, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths



Page No: 16 of 54

36.7603 MHz

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3.225 kHz

60.222 MHz*

#Peak

Log 10

dB/

Offst 25 dB

Transmit Freg Error

x dB Bandwidth



Occ BW % Pwr

x dB

-26.00 dB

99%/26 dB BANDWIDTH, 5745/5765 MHz, M7, HT-40, Dual Transmit Paths

99%/26 dB BANDWIDTH, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths



Page No: 17 of 54

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1 of 2



99%/26 dB BANDWIDTH, 5785/5805 MHz, M7, HT-40, Dual Transmit Paths

Page No: 18 of 54

Peak Output Power

15.247: The maximum conducted output power of the intentional radiator for systems using digital modulation in the 5725-5850MHz band shall not exceed 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum supported antenna gain for all bands is 7dBi. In beamforming mode, the 6dBi behaves as 7dBi+10log(n) (n=2 radiating elements) = 10dBi. Therefore the maximum allowable output power requires 4dB reduction in beam forming mode, and 1 dB reduction in all other modes.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Configure the spectrum analyzer as shown below.

Enable "Channel Power" function of analyzer

	•
Center Frequency:	Frequency from table below
Span:	20 MHz (must be greater than 26dB bandwidth, adjust as
necessary)	
Ref Level Offset:	Correct for attenuator and cable loss.
Reference Level:	20 dBm
Attenuation:	20 dB
Sweep Time:	100ms, Single sweep
Resolution Bandwidth:	1 MHz
Video Bandwidth:	3 MHz
Detector:	Sample
Trace:	Trace Average 100 traces in Power Averaging Mode
Integration BW:	=26 dB BW from 26 dB Bandwidth Data

After averaging 100 traces of the transmitter waveform on the spectrum analyzer, record the spectrum analyzer Channel Power.

Frequency (MHz)	Mode	Data Rate (Mbps)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
5745	Non HT-20 Beam Forming	54	20.4	26	5.598
5785	Non HT-20 Beam Forming	54	20.3	26	5.665
5825	Non HT-20 Beam Forming	54	20.4	26	5.575
5745/5765	Non HT-40 Duplicate	54	20.4	29	8.552
5745/5765	HT-40	M7	20.0	29	8.982
5785/5805	Non HT-40 Duplicate	54	20.4	29	8.628
5785/5805	HT-40	M7	20.7	29	8.325

Page No: 19 of 54



* Agilent	Measure
Ch Freq 5.745 GHz Trig Free Channel Power Averages: 100	Meas Off
	Channel Power
Ref 20 dBm #Atten 20 dB #Samp	Occupied BW
dB/ 0ffst 25	ACP
dB Center 5.745 00 GHz Span 30 MHz	Multi Carrier Power
#Res BW 1 MHz	Power Stat
Channel Power Power Spectral Density	CCDF
20.40 dBm /25.1000 MHz -53.59 dBm/Hz	More 1 of 2
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Peak Power, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths

Peak Power, 5785 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Page No: 20 of 54



🔆 Agilent	Measure
Ch Freq 5.825 GHz Trig Free Channel Power Averages: 100	Meas Off
	Channel Power
Ref 20 dBm #Atten 20 dB #Samp Log	Occupied BW
10 10<	ACP
dB Center 5.825 00 GHz Span 30 MHz	Multi Carrier Power
*Res BW 1 MHz #VBW 3 MHz #Sweep 100 ms (601 pts) Channel Power Power Spectral Density	Power Stat CCDF
20.42 dBm /29.1000 MHz -54.21 dBm/Hz	More 1 of 2
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Peak Power, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths

Peak Power, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths



Page No: 21 of 54

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Peak Power, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths



Page No: 22 of 54

🔆 Agilent Measure Meas Off Ch Freq 5.795 GHz Trig Free Channel Power Averages: 100 **Channel Power** #Atten 20 dB Ref 20 dBm #Samp| Occupied BW Log 10 dB/ ACP Offst 25 dB Multi Carrier Power Center 5.795 0 GHz Span 60 MHz #Res BW 1 MHz #VBW 3 MHz #Sweep 100 ms (601 pts) Power Stat **Channel Power Power Spectral Density** CCDF 20.68 dBm /57.0000 MHz -56.88 dBm/Hz More 1 of 2 Copyright 2000-2007 Agilent Technologies

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Peak Power, 5785/5805 MHz, M7, HT-40, Dual Transmit Paths

Page No: 23 of 54

Power Spectral Density

15.247: For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Configure the spectrum analyzer as shown below.

Frequency from table below
20 MHz
Correct for attenuator and cable loss.
20 dBm
20 dB
100s
3 kHz
10 kHz
Peak
Single
Peak Search

Record the Marker value.

Frequency (MHz)	Mode	Data Rate (Mbps)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
5745	Non HT-20 Beam Forming	54	-4.1	8	12.138
5785	Non HT-20 Beam Forming	54	-2.7	8	10.713
5825	Non HT-20 Beam Forming	54	-2.2	8	10.217
5745/5765	Non HT-40 Duplicate	54	-5.6	8	13.603
5745/5765	HT-40	M7	-2.9	8	10.929
5785/5805	Non HT-40 Duplicate	54	-5.5	8	13.485
5785/5805	HT-40	M7	-3.6	8	11.562

Page No: 24 of 54

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Power Spectral Density, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Page No: 25 of 54

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Power Spectral Density, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Page No: 26 of 54



Power Spectral Density, 5745/5765 MHz, M7, HT-40, Dual Transmit Paths



Page No: 27 of 54



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Power Spectral Density, 5785/5805 MHz, M7, HT-40, Dual Transmit Paths

Page No: 28 of 54

Conducted Spurious Emissions

15.247: In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer).

Span:	30 MHz-26 GHz
Reference Level:	20 dBm
Attenuation:	10 dB
Sweep Time:	5s
Resolution Bandwidth:	100 kHz
Video Bandwidth:	300 kHz
Detector:	Peak
Trace:	Single
Marker:	Peak

Record the marker waveform peak to spur difference

Frequency (MHz)	Mode	Data Rate (Mbps)	Conducted Spur Delta (dB)	Limit (dBc)	Margin (dB)
5745	Non HT-20 Beam Forming	54	56.7	30	26.7
5785	Non HT-20 Beam Forming	54	59.5	30	29.5
5825	Non HT-20 Beam Forming	54	59.9	30	29.9
5745/5765	Non HT-40 Duplicate	54	58.7	30	28.7
5745/5765	HT-40	M7	56.9	30	26.9
5785/5805	Non HT-40 Duplicate	54	57.0	30	27.0
5785/5805	HT-40	M7	59.6	30	29.6

Page No: 29 of 54



Conducted Spurs, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths 🔆 Agilent Freg/Channel

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Aylient						r r eq7 channer
Ref 20 dBm #Peak	\$	#Atten 10 dB		Mk	r4 23.14 GHz -51.98 dBm	Center Freq 20.0150000 GHz
Log 10 dB/ Offst						Start Freq 30.0000000 MHz
25 dB DI		2	3 4	مر ہے۔ ا	and the second	Stop Fred 40.0000000 GHz
-19.3 dBm June LgAv		and a second		Con Contraction		CF Step 3.99700000 GHz <u>Auto</u> Mar
Center 20.02 #Res BW 100 Marker T	GHz kHz Trace	#V Type	BW 300 kHz X Axis	Sp #Sweep 10	oan 39.97 GHz 0 s (601 pts) Amplitude	Freq Offset 0.00000000 Hz
1 2 3 4	(1) (1) (1) (1)	Freq Freq Freq Freq	5.78 GHz 11.57 GHz 17.36 GHz 23.14 GHz		10.66 dBm -53.74 dBm -48.81 dBm -51.98 dBm	Signal Track On <u>Off</u>
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				Page No: 30	of 54	

Conducted Spurs, 5785 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths



Conducted Spurs, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Dual Transmit Paths Agilent Freq/Channel

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🔆 Agilent Freq/Channel Mkr4 22.98 GHz Center Freq -50.38 dBm Ref 20 dBm #Atten 10 dB 20.0150000 GHz #Peak Log 10 Start Fred dB/ 30.0000000 MHz Offst 25 dB Stop Freq 40.0000000 GHz DI 3 4 mandhugen 2 -21.2 **CF** Step dBm 3.99700000 GHz LgAv Man Auto Center 20.02 GHz Span 39.97 GHz Freq Offset #Res BW 100 kHz #VBW 300 kHz #Sweep 10 s (601 pts) 0.00000000 Hz Type Freq X Axis 5.75 GHz Marker Trace Amplitude (1) (1) (1) 8.77 dBm -54.64 dBm Freq 11.49 GHz 23 Signal Track Freq 17.24 GHz -49.97 dBm 0n <u> 0ff</u> -50.38 dBm (1)Freq 4 22.98 GHz Copyright 2000-2007 Agilent Technologies

Conducted Spurs, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths

Page No: 31 of 54



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Conducted Spurs, 5745/5765 MHz, M7, HT-40, Dual Transmit Paths

🔆 Agilent Freq/Channel Mkr4 23.22 GHz **Center Freq** Ref 20 dBm -51.27 dBm #Atten 10 dB 20.0150000 GHz #Peak Log 10 Start Fred dB/ 30.0000000 MHz Offst 25 dB Stop Freq 40.0000000 GHz DI 3 2 rand Ô -22.3 mu Q **CF** Step dBm 3.99700000 GHz LgAv Man Auto Center 20.02 GHz Span 39.97 GHz Freq Offset #Res BW 100 kHz #VBW 300 kHz #Sweep 10 s (601 pts) 0.00000000 Hz Marker Trace Type X Axis Amplitude 5.80 GHz 11.61 GHz (1) (1) Freq 7.75 dBm -54.19 dBm Freq Signal Track -49.25 dBm -51.27 dBm 3 (1)Freq 17.42 GHz 0n Off (1)23.22 GHz 4 Freq Copyright 2000–2007 Agilent Technologies

Conducted Spurs, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths

Page No: 32 of 54



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Conducted Spurs, 5785/5805 MHz, M7, HT-40, Dual Transmit Paths

Page No: 33 of 54



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Title: Conducted Test Setup

Page No: 34 of 54

Appendix B: Emission Test Results

Testing Laboratory: Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134, USA

Radiated Bandedge

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

The following data reflects worst-case values of the AIR-ANT5160V-R (6dBi omni) and AIR-ANT-25137NP-R (7dBi patch) antennas.

Using Vasona, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). Place the radio in continuous transmit mode.

Span:	5350-5745 MHz for 5745MHz test, (Measure 5725MHz Horz & Vert) 5805-6500 MHz for 5805MHz test, (Measure 5850MHz Horz & Vert)
Reference Level:	110 dBuV
Attenuation:	20 dB
Sweep Time:	Coupled
Resolution Bandwidth:	1MHz
Video Bandwidth:	1 MHz for peak, 10 Hz for average
Detector:	Peak

Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

Save 2 plots:1) Average Plot (Vertical and Horizontal), Limit= 54dBuV @3m2) Peak plot (Vertical and Horizontal), Limit = 74dBuV @3m

Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands.

Frequency (MHz)	Mode	Data Rate (Mbps)	Radiated Band Edge Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
5745	Non HT-20 Beam Forming	54	67.5	68	0.5
5825	Non HT-20 Beam Forming	54	53.4	68	14.7
5745/5765	Non HT-40, Dual Tx Path	54	73.3	78	4.7
5785/5805	Non HT-40, Dual Tx Path	54	61.6	68	6.4



Radiated Bandedge, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Average

Radiated Bandedge, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Average



Page No: 36 of 54



Radiated Bandedge, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Average

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Radiated Bandedge, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Average Agilent R T Trace

Mkr1 5.850 00 GHz Ref 107 dB**µ**V #Peak Trace #Atten 10 dB 61.58 dBµV 2 1 Log ж 10 **Clear Write** dB/ Max Hold DI 68.2 dBµV Min Hold LgAv V1 V2 S3 FC View A AA £(f): FTun Blank Swp More Start 5.805 00 GHz Stop 6.000 00 GHz 1 of 2 #Res BW 1 MHz #VBW 1 kHz Sweep 152.1 ms (1604 pts) Copyright 2000-2008 Agilent Technologies

Page No: 37 of 54



Radiated Bandedge, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Peak

Radiated Bandedge, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Peak



Page No: 38 of 54



Radiated Bandedge, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Peak



Page No: 39 of 54

Radiated Spurious Emissions

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Using Vasona, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). Place the radio in continuous transmit mode.

Span:	1GHz – 18 GHz
Reference Level:	80 dBuV
Attenuation:	10 dB
Sweep Time:	Coupled
Resolution Bandwidth:	1MHz
Video Bandwidth:	1 MHz for peak, 10 Hz for average
Detector:	Peak

Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

Save 2 plots: 1) Average Plot (Vertical and Horizontal), Limit= 54dBuV @3m 2) Peak plot (Vertical and Horizontal), Limit = 74dBuV @3m

Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands.

Frequency (MHz)	Mode	Data Rate (Mbps)	Spurious Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
5745	Non HT-20 Beam Forming	54	49.1	54	4.9
5785	Non HT-20 Beam Forming	54	48.0	54	6.0
5825	Non HT-20 Beam Forming	54	48.0	54	6.1
5745/5765	Non HT-40, Dual Tx Path	54	49.6	54	4.4
5785/5805	Non HT-40, Dual Tx Path	54	47.7	54	6.3
5805/5785	Non HT-40, Dual Tx Path	54	49.6	54	4.4

Page No: 40 of 54



Radiated Spurious Emissions, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Average

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Mi Emission Soft				
#Atten 6 dE		Mkr4 1 39	1.590 GHz .40 dBµV 1	Trace
× 1		4		Clear Write
				Max Hold
				Min Hold
+ e Type	ŧVBW 1 kHz X Axis	Stop 18 Sweep 14.01 s (1 Am	8.000 GHz^ .604 pts) plitude	Viev
Freq Freq Freq Freq	2.437 GHz 5.795 GHz 9.748 GHz 11.590 GHz	46.40 35.5- 47.67 39.40	0 dBµV 4 dBµV 7 dBµV 0 dBµV	Blan
				More 1 of 2
	a Type Freq Freq Freq Freq Freq	#VBW 1 kHz *VBW 1 kHz *	3 4 4 4	3 4 * 4 4 * 4 4 * 4 4 * 4 4 * 5 18.000 GHz #VBW 1 kHz Sweep 14.01 s (1604 pts) * YBW 1 kHz Sweep 14.01 s (1604 pts) * Type X Axis Freq 2.437 GHz 46.40 dBµU Freq 5.795 GHz 35.54 dBµU Freq 9.748 GHz 47.67 dBµU Freq 9.748 GHz 39.40 dBµU Freq 11.590 GHz 39.40 dBµU

Page No: 41 of 54



Radiated Spurious Emissions, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Average

Radiated Spurious Emissions, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Average



Page No: 42 of 54

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Radiated Spurious Emissions, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Average

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Radiated Spurious Emissions, 5805/5785 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Average



Page No: 43 of 54



Radiated Spurious Emissions, 5745 MHz, 54 Mbps, Non HT-20 Beam Forming, Peak

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Agilent Trace R Т -356 Mkr2 5.785 GHz EMiSoft Vasona: EMi Emission Software Ref 75 dB**µ**V #Peak Trace 50.49 dBµV #Atten 10 dB 2 Log 3 4 2 10 **Clear Write** dB/ AIA Max Hold ΠI 74.0 dBµV Min Hold #LgAv Stop 18.000 GHz Start 30 MHz #Res BW 1 MHz #VBW 1 MHz View Sweep 36.01 ms (1604 pts) X Axis 2.437 GHz 5.785 GHz 9.748 GHz Amplitude 52.25 dBµV Marker Trace Type (1) (1) Freq 1 50.49 dBµV 55.15 dBµV Freq 2 Blank 3 (1)Freq 51.66 dBµV 4 (1)Freq 11.570 GHz More 1 of 2 Copyright 2000-2008 Agilent Technologies

Radiated Spurious Emissions, 5785 MHz, 54 Mbps, Non HT-20 Beam Forming, Peak

Page No: 44 of 54



Radiated Spurious Emissions, 5825 MHz, 54 Mbps, Non HT-20 Beam Forming, Peak

Radiated Spurious Emissions, 5745/5765 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Peak



Page No: 45 of 54

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Radiated Spurious Emissions, 5785/5805 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Peak

Radiated Spurious Emissions, 5805/5785 MHz, 54 Mbps, Non HT-40 Duplicate, Dual Transmit Paths, Peak



Page No: 46 of 54



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5GHz 6dBi MIMO Patch Antenna co-Located with 2.4GHz 6dBi MIMO Patch Antenna



5GHz 6dBi Omni Antennas

Page No: 47 of 54

Conducted emissions



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Test Results Table

Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.15	11.3	10.1	1.8	23.2	Av	N	56	-32.8	Pass	
0.15	39	10.1	1.8	51	Qp	N	66	-15	Pass	
0.155	39	10.1	1.7	50.8	Qp	N	65.7	-14.9	Pass	
0.155	10.9	10.1	1.7	22.7	Av	N	55.7	-33	Pass	
0.326	23.7	10.2	0.8	34.7	Av	N	49.6	-14.8	Pass	
0.326	27.2	10.2	0.8	38.2	Qp	N	59.6	-21.4	Pass	
2.152	20.3	10.3	0.4	31	Qp	N	56	-25	Pass	
2.152	18.8	10.3	0.4	29.5	Av	N	46	-16.5	Pass	
12.769	19.2	10.8	0.5	30.5	Av	N	50	-19.5	Pass	
12.769	24.2	10.8	0.5	35.6	Qp	N	60	-24.4	Pass	
16.354	18	11	0.7	29.6	Av	N	50	-20.4	Pass	
16.354	22.3	11	0.7	33.9	Qp	N	60	-26.1	Pass	

Page No: 48 of 54



Page No: 49 of 54





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Test Results Table

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
53.747	29.3	0.8	7.4	37.5	Qp	V	96	57	40.5	-3	Pass	
117.525	15.2	1.5	13.6	30.4	Qp	V	96	55	40.5	-10.2	Pass	
250.005	27.1	2.1	11.6	40.8	Qp	V	96	170	47.5	-6.7	Pass	
500.019	23.1	2.8	17.8	43.7	Qp	V	100	178	47.5	-3.8	Pass	
625.025	22.8	3.1	19	45	Qp	V	158	156	47.5	-2.5	Pass	
875.033	16	3.6	21.9	41.5	Qp	V	121	178	47.5	-6	Pass	

Page No: 50 of 54



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Title: Radiated Emissions Configuration Photograph

Page No: 51 of 54

Maximum Permissible Exposure (MPE) Calculations

15.247: U-NII devices are subject to the radio frequency radiation exposure requirements specified in Sec. 1.1307(b), Sec. 2.1091 and Sec. 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a ``general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Given

 $E=\sqrt{(30^{*}P^{*}G)/d}$ and $S=E^{2}/3770$

where

E=Field Strength in Volts/meter P=Power in Watts G=Numeric Antenna Gain d=Distance in meters S=Power Density in mW/cm²

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:

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d=√((30*P*G)/(3770*S))
```

P(mW)=P(W)/1000

Changing to units of power in mW and distance in cm, using:

d(cm)=100*d(m)

yields

d=100*√((30*(P/1000)*G)/(3770*S)) d=0.282*√(P*G/S)

where

d=Distance in cm P=Power in mW G=Numerica Antenna Gain S=Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using: P(mW)=10^(P(dBm)/10) G(numeric)=10^(G(dBi)/10)

yields d=0.282*10^((P+G)/20)/ \sqrt{S} Equation (1) and s=((0.282*10^((P+G)/20))/d)^2 Equation (2) where d=MPE distance in cm P=Power in dBm G=Antenna Gain in dBi S=Power Density in mW/cm^2

Page No: 52 of 54

Equation (1) and the measured peak power are used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 20 cm even if the calculations indicate that the MPE distance may be less.

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S=1mW/cm² maximum. The highest supported antenna gain is 7 dBi (10dBi with beamforming). Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

			Peak				
		Power	Transmit	Antenna	MPE		
Frequency	Bit Rate	Density	Power	Gain	Distance	Limit	Margin
(MHz)	(Mbps)	(mW/cm^2)	(dBm)	(dBi)	(cm)	(cm)	(cm)
5745	54	1	20.4	10	9.34	20	10.66
5785	54	1	20.4	10	9.34	20	10.66
5825	54	1	20.7	10	9.67	20	10.33

MPE Calculations

To maintain compliance, installations will assure a separation distance of at least 20cm.

Using Equation 2, the MPE levels (s) at 20 cm are calculated as follows:

			Peak				
		MPE	Transmit	Antenna	Power		
Frequency	Bit Rate	Distance	Power	Gain	Density	Limit	Margin
(MHz)	(Mbps)	(cm)	(dBm)	(dBi)	(mW/cm^2)	(mW/cm^2)	(mW/cm^2)
5745	54	20	20.4	10	0.22	1	0.78
5785	54	20	20.4	10	0.22	1	0.78
5825	54	20	20.7	10	0.23	1	0.77

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Equip #	Manufacturer	Model	Description	Last Cal	Next Due
CIS002119	EMC Test Systems	3115	Double Ridged Guide Horn Antenna	30-Jun-10	30-Jun-11
CIS005691	Miteq	NSP1800-25-S1	Broadband Preamplifier	12-Oct-09	12-Oct-10
CIS008195	TTE	H613-150K-50-21378	Hi Pass Filter - 150KHz cutoff	5-Jan-10	5-Jan-11
CIS045995	Fischer	F-090527-1009-2	LISN Adaptor	22-Jun-10	22-Jun-11
CIS020975	Micro-Coax	UFB311A-0-1344-520520	RF Coaxial Cable, to 18GHz, 134.4 in	25-Feb-10	25-Feb-11
CIS025662	Micro-Coax	UFB311A-1-0840-504504	RF Coaxial Cable, to 18GHz, 84 in	4-Mar-10	4-Mar-11
CIS030559	Micro-Coax	UFB311A-1-0950-504504	RF Coaxial Cable. to 18GHz. 95 in	25-Feb-10	25-Feb-11
CIS030652	Sunol Sciences	IB1	Combination Antenna, 30MHz-2GHz	27-Jul-10	27-Iul-11
CIS031700	Micro-Tronics	BRC50705	Notch Filter, SB:5,725-5,875GHz	4-lun-10	4-lun-11
0.0001700	Midwest				
CIS034972	Microwave	ATT-0640-20-29M-02	Attenuator, 20dB	14-May-10	14-May-11
CIS036716	Cisco	RF Coaxial Cable-SMA	Radio Test Cable, SMA-SMA	15-Dec-09	15-Dec-10
CIS037581	ETS-Lindgren	3117	Double Ridged Waveguide Horn Antenna	22-Jun-10	22-Jun-11
CIS038371	Cisco	TH0118	Mast Mount Preamplifier Array	17-Nov-09	17-Nov-10
CIS040603	Agilent	E4440A	Spectrum Analyzer	04-Aug-10	04-Aug-11
CIS041990	MegaPhase	FM18-NKNK-320	RE 18GHz N-Type cable	25-Feb-10	25-Eeb-11
COM000590	Agilent	F4448A	Spectrum Analyzer	28-May-10	28-May-11
COM000601	Agilent	E4417A	EPM-P Series Power Meter	5-Oct-09	5-Oct-10
COM000602	Agilent	E9327A	Peak and Avg Power Sensor	5-Oct-09	5-Oct-10

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Appendix C: Test Equipment/Software Used to perform the test

Page No: 54 of 54